ALVARION REPLY COMMENTS

Before the
Federal Communications Commission
Washington, D.C. 20554

In the matter of	)	
	)	
Modification of Parts 2 and 15 of the	)	
Commission's Rules for unlicensed devices and	)	ET Docket No. 03-201
equipment approval.	)	

INTRODUCTION

Alvarion appreciates the opportunity to register official comment with respect to the FCC's Notice of Proposed Rulemaking regarding the revision to the Part 15 rules for unlicensed devices. Alvarion is the world's leading pure play provider of wireless broadband solutions and we are a very pro-active leader. We develop and market carrier-class solutions from 800MHz to 26GHz, covering applications as diverse as high-speed Internet access, TDM voice, cellular backhaul, mobile broadband, public hotspots, and enterprise bridging. While Alvarion's leadership may be measured in units deployed (more than 1.5 million), countries deployed (over 125), and most any other significant metric, Alvarion has also been a principal leader in the wireless standards development process from the first IEEE 802.11 WLAN standard to the recent IEEE 802.16.

From Iceland to Chile, from India to Ireland, from Namibia to Russia, from Cambodia to New Zealand, the globe's largest wireless broadband deployments in almost every region are Alvarion based. In the U.S., approximately 200 telephone companies, 60 utilities, 800 ISPs, many municipalities, several large regional cellular carriers, and a number of cable MSO's are delivering wireless broadband services to several hundred thousand subscribers using Alvarion's BreezeACCESS multi-point solution. BreezeACCESS integrates 900MHz, 2.4GHz, MMDS, 3.5GHz, and multiple 5GHz bands into a single solution with end user speeds from 3Mbps to 24Mbps. Significant deployments can be found in markets as rural as Jefferson County, Nebraska with a population as of only 8,250, but where Diode Communications has over 1,000 fixed wireless broadband customers to as metro as San Diego County, California, where over 500 sheriff's deputy vehicles have mobile broadband access.

Accordingly, as a market leader, Alvarion accepts the responsibility and respectfully offers the Commission the following set of comments (indicated by leading paragraph with [Alvarion Comment]).

A. Proposed Revisions to Part 15

1. Advanced Antenna Technologies

1. As unlicensed Part 15 spread spectrum use in the 2.4 GHz band for wireless networking has grown, so has the development of more efficient antenna technologies. The current spread spectrum rules, however, do not contemplate emerging advanced antenna technologies in that they only provide for the use of omnidirectional and point-to-point antennas. Omnidirectional antennas radiate and receive equally in all directions. While a system of this type is adequate for simple RF environments, the omni-directional approach reaches desired users with only a small percentage of the overall energy sent out into the environment; signals that miss intended users represent wasted energy and could become interference to other users. Omnidirectional antennas can sometimes use spectrum in an inefficient manner by, for example, limiting frequency reuse. Under the current spread spectrum rules, omnidirectional antennas are

limited to 1 watt transmitter output power and an antenna gain of 6 dBi, resulting in a transmitted signal of 4 watts E.I.R.P. If an antenna with greater than 6 dBi gain is used, the transmitter output power must be reduced by the amount in dB that the antenna gain exceeds 6 dBi, thereby fixing the maximum E.I.R.P. to 4 watts.[1]

2. The rules also provide for use of directional antennas for point-to-point operations. Directional antennas concentrate their energy to allow the same 1 watt of transmit output power to produce a signal that propagates much further in its intended direction while limiting emissions in all other directions. The resulting radiation pattern resembles an elongated oval extending from the antenna structure. Because these antennas limit RF radiation in any direction other than the desired communication path, the rules allow point-to-point antennas to employ higher gain with less than a one-to-one reduction in power. Fixed point-to-point antennas operating in the 2.4 GHz band are allowed to operate with directional gain greater than 6 dBi provided the maximum peak output power is reduced by 1 dB for every 3 dB that the antenna gain exceeds 6 dBi.

3. Systems employing advanced antenna designs such as sectorized antennas and phased array adaptive antennas are now being used, or contemplated for use, as part of wide area network systems operating in the Part 15 bands. Sectorized antenna systems take a traditional omnidirectional coverage area and subdivide it into fixed sectors that are each covered using a single beam or antenna element to transmit desired information to all devices in the sector. For example, a sectorized system can be made from two individual antennas, each covering 60º of azimuth around the antenna structure, resulting in 120º of coverage. Operationally, each sector is treated as a different cell, the range of which is greater than that of a system using a single omnidirectional antenna. A phased array antenna system consists of a group of radiating elements arranged and driven in such a way that their radiated fields add in some directions and cancel in others. The combined fields can produce a single beam, or multiple beams, pointing in a various directions while minimizing radiation in other areas. Properties of the resultant beams such as intensity, directionality, or beamwidth can be adjusted by altering the input signal to each radiating element.

4. Sectorized and phased array antennas are used to create dynamic communication links with associated mobile or fixed devices in any direction around an antenna structure. This enables an application like a broadband local area network to serve a number of spatially separated clients from a single antenna system. These antennas allow systems to use spectrum more efficiently by making it possible to re-use a given frequency to communicate with different devices along non-overlapping paths.

5. The current rules are unclear regarding the treatment of sectorized and phased array systems. On one hand, if the antenna systems are allowed to operate at the higher point-to-point limits using the same frequency to communicate with a large number of clients located in various positions around the antenna site, the system would mirror the behavior of a point-to-multipoint or omnidirectional system and pose an increased risk of interference to other devices. On the other hand, these antennas, configured correctly, can be used to increase spectral efficiency by assigning spectrum usage on a dynamic basis according to user demand and re-using the same frequency to transmit different information to customers who are in different directions. In such a case, the same frequency may be reused multiple times within a geographical area to serve varied users.

6. We believe that it is in the public interest to accommodate efficiently configured sectorized and phased array antenna technologies. To date, the Commission has not generally authorized the operation of sectorized antennas by spread spectrum systems, but, by individual interpretation of its

[1] 47 C.F.R. § 15.247(b)(4).

rules, we have allowed a few phased array systems to operate.[2] However, we are receiving an increasing number of questions about how to accommodate these multiple beam systems in spread spectrum operations. After taking these requests under consideration, we tentatively conclude that spread spectrum systems using sectorized and/or phased array systems could provide important benefits for providing communications to a local area. We also believe that those benefits would outweigh the concerns for interference, *i.e.*, spectrum overcrowding, if the devices comply with appropriate operating conditions. Therefore, we believe that we should revise the rules to clearly facilitate broader deployment of advanced antenna designs with spread spectrum systems and to provide a stable environment in which to foster the continued development and installation of these spectrum efficient technologies.

7. In order to adopt regulations for sectorized and phased array antenna systems used with spread spectrum systems, we must first provide a clear definition of the types of systems that will be accepted. We seek comment regarding the characteristics that a system would need to exhibit in order to be classified as a sectorized or phased array antenna system. As an initial matter, we propose to clarify that sectorized or phased array antenna systems must be capable of forming at least two discrete beams. Second, we propose to limit the total simultaneous beamwidth radiating from the antenna structure to 120º, regardless of the number of beams formed. The 120º of bandwidth need not be continuous and may be divided among various independent beams pointing in different directions around the antenna structure. In this implementation, a sector system or phased array would be permitted to transmit simultaneously in 2 beams of 60º, 10 beams of 12º, or any other combination not exceeding a total of 120º beamwidth. Such a regulation would prevent abuse of our rules by banning phased array systems which, in an extreme case, may be able to form beams of 1º width simultaneously along 360 radials around an antenna structure. An antenna system of such design would appear identical to an omni-directional antenna. Commenting parties should provide detailed suggestions regarding any additional modes of operation that should be considered acceptable as a definition for sectorized or phased array installations.

[Alvarion Comment]

We propose for clarification that "antenna structure" is to mean the specific antenna, array or group of antennas connected to a specific radio transmitter or group of radio transmitters.

We agree with the limitation of 120˚ of total beamwidth being transmitted simultaneously as long as the limitation applies only to the same channels or frequencies. We suggest using the 6 dB bandwidth of the modulated transmission as the definition of the frequencies used within the 120˚. With this definition, another two antenna structures, each limited to 120˚, can be simultaneously transmitted using different frequencies, yet keep the interference level on any one group of frequencies limited to 120˚.

We agree with the Commission that the proposed rule will statistically lower the interference floor, and as long as any simultaneous transmissions occurring in addition to the 120˚ is doing so on other frequencies on another antenna structure.

We offer the following as a practical example; a given base station system that utilizes a sectorized antenna system, may be designed using outdoor units (RF front end) with each connected to one of three 120 degree antennas. The system is capable of transmitting on any 1 of the discrete 120 degree sector beams, or all three simultaneously, but each on different frequencies. The EIRP for each antenna would be limited to the PTP limit based on the antenna gain. The same system could be arranged

[2] *See* equipment authorizations for Vivato, Inc., FCC ID Nos. QLN-DP2310P0001 and QLNVLJ24WFSW. See also equipment authorization for Navini Networks, Inc., FCC ID No. PL6-ISM-BTS-R1. Information pertaining to these grants can be accessed via the FCC's database at https://gullfoss2.fcc.gov/prod/oet/cf/eas/reports/GenericSearch.cfm.

such that each outdoor unit is attached to one of the three input ports of each of the three 120 degree antennas from which each can form three discrete 40 degree beams. In other words, each ODU is radiating in 120 degrees total on the same frequency. The transmitter power is increased by the 10 Log(3) and the EIRP is the same. If expanded to use 6 outdoor units, each transmitting on different frequencies on no more than 120˚, the same 10 Log(6) increase in TX power would be applied with the EIRP remaining the same.

8. Sectorized and phased array antenna systems divide the total power from a transmitter among various transmission azimuths and the power may be distributed equally or at varying levels among those azimuths. The radiated emissions are directionalized along each sector or azimuth in order to communicate with an associated receiver. Accordingly, these antenna systems may resemble point-to-point operation at any given moment. Therefore, we propose to allow such systems to operate at the same power levels as point-to-point directional antennas. Specifically, we propose to limit the total power that may be applied to each individual beam to the applicable power level specified in Section 15.247(b), *i.e.,* 0.125 watt or 1 watt, depending upon the type of modulation used.[3] This implies that the total operating power, the aggregate power in all beams, could exceed the output power permitted for a single point-to-point system. We propose, therefore, to limit the aggregate power transmitted simultaneously on all beams to 8 dB above the limit for an individual beam. For instance, the 8 dB limit will enable antenna systems to create up to 6 individual beams or sectors, all operating at the point-to-point limit. Such an implementation is based on our understanding of the capabilities of existing technology. Finally, we propose to require that the transmitter output power be reduced by 1 dB for each 3 dB that the directional antenna gain of the complete system exceeds 6 dBi. This requirement is similar to the present rules for point-to-point operation in the 2.4 GHz band. We seek comment on these proposals. Further, we seek comment with regard to whether the Commission should specify a maximum E.I.R.P. limit for each individual beam. If so, what should that limit be?

[Alvarion Comment]

We feel these same provisions should also be applied to products operating in the 5.725 – 5.850 GHz band under the same conditions described above, except for the EIRP limits would be limited according to the established EIRP limits of the band.

9. We note that certain antenna designs also employ adaptive properties such as steerability or beamforming characteristics.[4] The proposed rules will not require that the individual sectors or beams be adaptive. Therefore, the rules will be technology neutral and able to accommodate various antenna system designs. With this in mind, we seek comment regarding additional restrictions which may be needed. For example, a phased array antenna system may be able to produce dynamic beams which can overlap one another. In such a case, should there be an additional power reduction required whenever two or more beams overlap?

10. The proposed rules will accommodate the phased array antenna systems which the Commission has previously allowed by interpretation of the rules. These systems are now either in advanced stages of development or already deployed in the field. We seek comment with regard to the treatment of existing systems in light of any rules adopted as a result of this proceeding. We propose the following compliance schedule: all newly certificated systems must comply upon the effective date of the

[3] 47 C.F.R. § 15.247(b).

[4] Steerability refers to a system's capability to complete an RF link with a given client and to subsequently maintain that link while the client is mobile by steering the beam to track the client's movements. Beamforming refers the ability to create static beams of various widths and power levels along different azimuths around the antenna structure.

new rules; certificated systems marketed six months after the effective date must comply with any new rules. We do not propose to require any modifications to existing certificated equipment that is deployed in the field.

11. We ask if there is any need to modify the compliance testing requirements for systems that employ multiple antennas or radiating elements. Section 15.31(h) of the rules requires that compliance measurements for systems with multiple antennas must be taken with all radiating sources emitting.[5] Should this requirement be applicable to the special case of sector or phased array antennas? Sector antenna systems in particular typically complete a communications link by utilizing specific radiating elements to form a beam. Therefore, testing these systems with all elements radiating simultaneously will not replicate real-world operation. Is the same true for phased array systems? Is it necessary for all radiating elements of sector or phased array antennas to be emitting in order to determine potential out-of-band and spurious emission levels?

[Alvarion Comment]

We suggest all antenna elements attached to a specific transmitter be tested while radiating in a configuration indicative of real-world operation. In other words, if only a single transmitter is connected to an antenna structure capable of covering 360˚, with only 120˚ being transmitted simultaneously, then the entire structure should be included in the test with the maximum (120˚) and minimum beamwidths being tested. Conversely, if more than one transmitter is connected to an antenna structure, then the maximum number intended to be support in real operation should be tested.

2. Replacement Antennas for Unlicensed Devices

12. Section 15.203 requires that intentional radiators be designed such that no antenna other than that supplied can be used with the device.[6] The rules state that the device can be designed such that a broken antenna can be replaced by the user; however, the use of a standard antenna jack or electrical connector is prohibited. These rules are intended to prevent intentional circumvention of the Part 15 emission limits by replacing a device's authorized antenna with an antenna having higher gain characteristics.

13. We wish to develop more flexible antenna requirements for unlicensed devices. We propose to provide that flexibility by requiring testing only with the highest gain antenna of each type that would be used with the transmitter at the maximum output power of that transmitter. Any antenna of a similar type that does not exceed the antenna gain of tested antennas may be used without retesting. Use of an antenna of a different type than the tested antenna (*i.e.* yagi antenna vs. a horn antenna)[7] or one that exceeds the gain of a tested antenna would require retesting and new approval by either a Telecommunication Certification Body or the Commission. Manufacturers would be expected to supply a list of acceptable antenna types with applications for equipment authorization.

[Alvarion Comment]

We agree with this proposal and believe such a ruling will benefit both the user and the equipment manufacturer by relieving the burden to test all antennas to the product. We do see a need that

[5] 47 C.F.R. § 15.31(h).

[6] 47 C.F.R. § 15.203.

[7] A yagi antenna, similar to the common rooftop TV antenna, has different transmit and receive properties than a horn type antenna used on microwave towers. Therefore, simply replacing one with the other would result in a change in the radiated signal pattern.

the antenna types are classified more specifically and give more examples of what types of antenna are included in a classification. For example, parabolic type antenna should include those with solid or grid reflector, and center fed or offset fed. Or, panel type antenna should include any measure of E or H plane beam width as long as the highest gain is tested.

3. Flexible Equipment Authorization for Radio Transmission Systems

14. Wireless internet service providers (WISPs) have expressed a desire for more flexibility in the Part 15 equipment authorization rules so that they can mix and match the components of a radio transmission system without the need to obtain an equipment authorization for every combination.[8] The rules generally require equipment authorization for a complete device, including the radio transmitter and a specific antenna. Further, Section 15.205 prohibits marketing of external radio frequency amplifiers, except as part of a complete transmission system consisting of an intentional radiator, external radio frequency amplifier and antenna.[9] The system may only be used in the configuration that was authorized. WISPs assert that they often experience difficulty in tailoring their radio transmission systems to meet particular needs due to the lack of flexibility in equipment authorization. For example, WISPs may be unable to change antennas to suit a particular application, even though such a change does not alter the operating parameters of the system. They assert that increased flexibility would foster competition in the supply of equipment and allow for greater innovation in the design of systems appropriate to the particular engineering challenges each WISP faces.

15. We are proposing a number of rule changes to enable WISPs to customize their transmission systems without the need to obtain a new equipment authorization for every combination of components. Specifically, we will allow professional radio system installers and parties that offer a commercial radio service under the unlicensed rules to substitute technically equivalent components in systems that have been granted equipment authorization.[10] We believe such parties have the technical competence to ensure that the systems they deploy continue to comply with the FCC rules.[11] We invite comment as to whether specific criteria are necessary to qualify as a professional radio system installer or commercial service provider, and if so, what those criteria should be. We also request views as to whether any other parties should be afforded similar flexibility. We will require the professional installer or commercial service provider to place a label on the transmission system that lists the FCC Identification Number of the system that was granted equipment authorization, identifies any components that were substituted, and designates a point of contact for the party that installed the system.

16. We also propose to allow marketing of separate radio frequency power amplifiers on a

[8] *Spectrum Policy Task Force Report*, ET Docket No. 02-135, November 2002, at 54 and Recommendation 35 at 67: WISPs and point-to-point microwave systems the Commission should facilitate greater flexibility by making it easier for operators to better tailor their equipment for particular applications.

[9] 47 C.F.R. § 15.204.

[10] Organizations such as WISPs or colleges and universities that provide radio services for a fee will be eligible to make use of the flexibility we propose herein.

[11] We believe that this recommendation is consistent with prior recommendations for professional installation. For example, we note that the Commission has recommended use of professional installers for certain two-way fixed wireless subscriber equipment. The Commission stated that professional installation will minimize the possibility that an antenna will be placed in a location that is likely to expose persons to the transmit signal at close proximity and for an extended period of time. *See First Report and Order and Further Notice of Proposed Rulemaking in WT Docket No. 99-217, Fifth Report and Order and Memorandum Opinion and Order and Memorandum Opinion and Order in CC Docket No. 96-98, and Fourth Report and Order and Memorandum Opinion and Order in CC Docket No. 88-57*, 15 FCC Rcd. 22983, ¶ 119 (2000).

limited basis. We will restrict such marketing to amplifiers that are only capable of operation under the spread spectrum rules in Section 15.247 and under the U-NII rules for the 5750 – 5850 MHz band. These are the rules under which WISPs currently offer most service and under which most unlicensed wireless broadband devices operate.[12] Further, we propose to require that such amplifiers obtain an equipment authorization (certification) and demonstrate that they cannot operate with an output power of more than 1 Watt, which is the maximum permitted under the rules. We believe that this rule change would be of benefit not only for WISPs, but also for consumers and businesses generally. For example, consumers and businesses would have the ability to obtain a separate amplifier if they find the device they have purchased has insufficient operating range to meet their needs. We invite comment as to whether we should instead provide only a more narrow relaxation to allow separate marketing of power amplifiers that are designed in a way such that they can only be used with a specific system that is covered by an equipment authorization, such as through use of a unique connector or via an electronic handshake with a host device. We also recognize that frequency hopping systems that employ fewer than 75 hops are limited to an output power of 125 mW and invite comment as to whether the unique connector requirement may be necessary to ensure that 1 Watt amplifiers are not used with devices that are limited to 125 mW. We invite comment on these proposals and solicit views on other ways the equipment authorization rules might be modified to provide added flexibility without creating undue risk of interference to radio services or unlicensed devices.

[Alvarion Comment]

We agree with the Commissions proposed rule to allow the substitution of technically equivalent components as long as these components are passive devices, such as cables and antennas. For active devices, such a RF power amplifiers, the improper installation and operation of such amplifiers can cause interference such that other equipment attempting to share the band will suffer in performance and or range. We know from our own experiences that aftermarket amplifiers vary significantly in function, linear gain, and IP3 performance. These amplifiers are not necessarily interchangeable because input levels will vary as a function of the cable losses and transmitter power of the source radio. It is possible that an amplifier can increase the output power, but be operating in compression and make the adjacent channels unusable, yet still meet the out of band emissions. We do not support this proposal and feel there is no way to ensure all the professional installers can ensure the substituted combination of equipment is performing within the FCC rules. In fact, Alvarion would like the FCC to not only restrict the "marketing" of such amplifiers, but to actually and explicitly "prohibit" the use of after market amplifiers if such amplifiers are not specifically included within the system certification. Such use of aftermarket amplifiers has historically been the basis of some of the most significant interference and the most blatant abuses, intentionally or otherwise, of the current Part 15 rules. However, if active devices like RF power amplifiers are tested to comply with the FCC rules as a system (like the present rules), and if such devices are sold independently with a list of the FCC IDs which the equipment can be operated with, then compliance with the FCC rules can be maintained. The documentation should also include any specific instructions for cable lengths, antenna gain, or filters that was required for compliance.

4. Measurement Procedures for Digital Modulation Systems

17. The current rules permit digitally modulated systems to operate in the 5.7 GHz band under either the Part 15 U-NII rules or the Section 15.247 spread spectrum rules. Under either set of

[12] We are not proposing to allow radio frequency amplifiers in the 5150 – 5350 MHz U-NII band. We note that the 5150-5250 MHz band is restricted to indoor operation only. Further, we understand that some WISPs offer service using the 5250 – 5350 MHz U-NII band, however, because the output power is limited to only 200 mW there is little need to use external radio frequency amplifiers in this spectrum.

rules, the devices are limited to a maximum output power of 1 watt.[13] However, the method used to determine the maximum power varies for U-NII use and spread spectrum use. Specifically, the output power measurement made in accordance with the Commission's U-NII device test procedure is an average measurement, while the output power measurement made in accordance with the Commission's digitally-modulated spread spectrum device test procedure is a measurement of the overall peak emission. In adopting the U-NII rules, the Commission recognized that digital modulation techniques often display short duration peaks that do not cause increased interference to other operations. Measuring the peak level of short duration spikes overestimates interference potential. Accordingly, the Commission established measurement procedures for digital U-NII devices which allow for averaging output power in order to disregard these insignificant spikes.[14]

18. The Commission recently amended Section 15.247 in the *Second Report and Order* in ET Docket No. 99-231 to accommodate advanced digital modulation techniques similar to U-NII devices.[15] However, no changes were made to the measurement methods for devices authorized pursuant to Section 15.247. As a result, the current rules may lead to inconsistent treatment of similar devices. For example, a Wi-Fi 802.11g device certified pursuant to Section 15.247 uses orthogonal frequency division multiplexing (OFDM); likewise, a Wi-Fi 802.11a device certified pursuant to the U-NII specifications also uses OFDM. However, compliance testing for these similar devices is different. We believe that the measurement procedures for digital modulation devices should be consistent, regardless of the rule section under which the devices are authorized. Since the rule modifications adopted in ET Docket No. 99-231 were intended to permit operation of devices using digital modulation similar to those authorized by the U-NII rules for the 5.7 GHz band to operate in the 2.4 GHz and 915 MHz bands, it is logical to require such devices to meet similar standards.

19. Accordingly, we propose to harmonize the measurement procedures for digital modulation devices authorized under Section 15.247 with the digital U-NII devices authorized under Section 15.407. Specifically, we propose to allow entities performing compliance testing for Section 15.247 devices to use an average, rather than overall peak, emission as provided by Section 15.407, paragraphs (a)(4) and (a)(5) when measuring transmit power. We propose this change for devices using digital modulation that operate in the 915 MHz, 2.4 GHz and 5.7 GHz bands. We seek comment on whether a change in measurement procedure for such devices would have any detrimental impact on the installed base of products.

20. Aside from the differences in measurement procedures, Section 15.247 and U-NII devices also differ in spectrum occupancy characteristics. For example, a Section 15.247 device operating in the 5.7 GHz band is required to limit peak power spectral density to 8 dBm in any 3 kHz band, which equates to 33 dBm in any 1 MHz band.[16] Unwanted emissions from such a device are not required to be attenuated to the general emission limits of Section 15.209.[17] Conversely, the same device, if authorized pursuant to the U-NII rules, would be required to limit its power spectral density to 17 dBm in any 1 MHz band and to limit unwanted emissions to the levels specified in Section 15.209.[18] Realizing that a device may occupy the same spectrum band differently depending upon the rule section under

[13] *See* 47 C.F.R. §§ 15.247(b)(3) and 15.407(a)(3).

[14] *See* 47 C.F.R. §§ 15.407(a)(4) – (a)(6).

[15] *Second Report and Order* in ET Docket No. 99-231, 17 FCC Rcd. 10755 (2002).

[16] *See* 47 C.F.R. § 15.247(d).

[17] *See* 47 C.F.R. § 15.247(c). Only those radiated emission that fall into the restricted bands as defined in 47 C.F.R. § 15.205(a) must comply with the radiated emission limits specified in 47 C.F.R. § 15.209(a).

[18] *See* 47 C.F.R. §§ 15.407(a)(3) and 15.407(b)(3); respectively.

which it is authorized, would a common procedure for measuring output power be appropriate and provide an accurate assessment of device performance? Should we amend the spectrum occupancy rules for Section 15.247 and U-NII devices to apply the same limits to both types of devices, and if so, which limits should be applied?

5. Frequency Hopping Channel Spacing Requirements

21. In its comments filed in response to the 2002 Regulatory Flexibility Act Review,[19] the Bluetooth Special Interest Group (Bluetooth SIG) suggests a modification of the channel separation requirement for frequency hopping spread spectrum systems.[20] Section 15.247(a)(1) of the rules requires that frequency hopping systems have hopping channel center frequencies separated by either a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.[21] The Bluetooth SIG requests that this channel spacing requirement be modified to allow hopping channel carrier frequencies to be more closely spaced. In particular, it seeks to modify the requirement to allow a separation of a minimum of 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater. Although the request did not specify the operating band to which the changes should apply, we interpret the request as being applicable to devices operating in the 2.4 GHz band because the Bluetooth product line operates in the 2.4 GHz band.

22. The Bluetooth SIG is requesting this modification to accommodate next generation Bluetooth technology which will use advanced modulation schemes capable of higher data rates than existing Bluetooth devices.[22] Specifically, Bluetooth devices conforming to the present rules operate at a data rate of up to 1 Mbps. Second generation Bluetooth devices employing new modulation techniques will be capable of data rates of up to 3 Mbps. This improvement will enable future Bluetooth devices to be used for more data intensive applications like wireless local area networks.

23. The Bluetooth SIG states that the current-channel spacing requirements are met using modulation techniques such as frequency shift keying, which is characterized by signals with relatively high signal peaks and steep drop-offs. However, its new modulation technique has a relatively low signal peak with more gradual signal drop-off. The resulting hopping channel bandwidths are slightly wider than the channel bandwidths of systems using older modulation techniques. The Bluetooth SIG selected the new modulation technique for its second generation product because the technique is backward compatible with existing modulation schemes.[23]

24. The Commission supports introducing more spectrally efficient technologies, and we seek to ensure that unnecessary regulations do not hinder industry efforts. For example, in 1999, the Commission initiated ET Docket 99-231 to re-examine the regulations for spread spectrum devices operating pursuant to Section 15.247. In subsequent actions in that docket, the Commission modified its rules to permit a wider array of modulation schemes to improve system performance, yet not increase

[19] *See* Comment of the Bluetooth SIG, DA 02-2152, November 8, 2002.

[20] Frequency hopping spread spectrum systems spread their energy by changing, or "hopping," the center frequency of the modulated signal in accordance with a psuedorandomly generated list of channels.

[21] *See* 47 C.F.R. § 15.247(a)(1). The bandwidth of a hopping channel is determined by measuring the bandwidth between points on both sides of the maximum power frequency at which the power drops to 20 dB below the maximum power.

[22] *See* Comments of the Bluetooth SIG, filed in DA 02-2152.

[23] *See* Bluetooth SIG comments at 4.

interference potential.[24]

25. Accordingly, we propose to modify the frequency hopping spacing requirement to permit certain systems in the 2.4 GHz band to utilize hopping channels separated by either 25 KHz or two-thirds of the 20 dB bandwidth, whichever is greater. We recognize that although a single device's channels will not overlap in time, the use of multiple devices simultaneously in a given area may cause the spectral occupancy and power density to increase, leading to an increased risk of interference. Therefore, we seek comment on the interference potential of new waveforms with more gradual roll-off and potentially higher spectral power densities at the channel band edges.

26. We note that the current rules place output power limitations on frequency hopping systems based upon the number of hopping channels used. Specifically, systems in the 2.4 GHz band that use at least 75 hopping channels are allowed 1 watt output power.[25] However, systems that use fewer than 75 hopping channels are limited to 125 mW output power.[26] In general, many systems that employ fewer than 75 hopping channels use hopping channels that are wider than those that use 75 or more channels. In allowing these wider hopping channels, the Commission recognized that a reduction in the maximum permitted output power was needed in order to minimize any potential interference risk.[27] We tentatively conclude that an output power limit of no more than 125 mW is also appropriate for those systems that use more narrowly spaced channels than currently permitted. In line with previous Commission findings, we believe that this restriction will ensure that systems using the narrow-spaced, slightly wider hopping channels will not overcrowd the 2.4 GHz band with relatively high-power emissions. We seek comment on this proposal.

6. Part 15 Unlicensed Modular Transmitter Approvals

27. In recent years, manufacturers have developed radio modules that can be incorporated into many different devices. The modules generally consist of a completely self-contained radiofrequency transmitter missing only an input and a power source to make it functional. Once the modules are authorized by the Commission under our certification procedure, they may be incorporated into a number of host devices such as, PCs or PDAs, which have been separately authorized.[28] The completed product generally is not subject to requirements for further certification by the FCC. Therefore, modular transmitters save manufacturers the time and any related expenses that would be incurred if a new equipment authorization were needed for the same transmitter when it is installed in a new device.

28. In response to manufacturers' request for guidance about the conditions under which approvals for modular transmitters may be granted, the Commission released a *Public Notice* in 2000 entitled "Part 15 Unlicensed Modular Transmitter Approval."[29] The *Public Notice* detailed eight criteria which must be met in order for the Commission to grant certification for modular transmitters. The *Public Notice* only contemplated a device where all of the radio frequency components were contained

[24] *See First Report and Order* in ET Docket 99-231, 15 FCC Rcd. 16244 (2000). *See also Second Report and Order* in ET Docket 99-231, 17 FCC Rcd. 10755 (2002).

[25] 47 C.F.R. § 15.247(b)(1).

[26] *Id.*

[27] *See First Report and Order* in ET Docket 99-231, 15 FCC Rcd 16244 (2000) at paragraph 15.

[28] The Commission's equipment certification authorization procedure is set fort in Section 2.907 and 2.1031 – 2.1060, 47 C.F.R. §§ 2.907 and 2.1031 – 2.1060.

[29] *See Public Notice,* Part 15 Unlicensed Modular Transmitter Approval, DA 00-1407, released June 26, 2000.

completely within the module itself.

29. A new class of "partitioned" modular devices is now under development. These transmitters consist of two basic components: the "radio front end," or radio elements and the "firmware" or specific hardware on which the software that controls the radio operation resides. The radio front end and firmware can each be self-contained units. The radio front end is generally a stand-alone unit while the firmware may either be a stand-alone unit or may be collocated within a device on a host system. A further partitioning is also possible by removing the local oscillator and tuning capacitors the antenna from the radio front end. The separation of modular units into these even smaller components will provide manufacturers the flexibility to design a larger variety of modular systems by mixing and matching individual components.

30. We believe that it is appropriate to update the Commission's practices for approving modular transmitters to accommodate both existing modular devices and emerging partitioned modular architectures (consisting of the firmware, radio front end, local oscillator and tuning capacitors, and antenna), so long as they meet certain guidelines. Accordingly, we are proposing to codify the eight criteria for approving modular transmitters contained in the 2000 *Public Notice*.

31. The eight requirements for obtaining modular transmitter approvals as documented in the 2000 *Public Notice* are re-printed below:

1. The modular transmitter must have its own RF shielding. This is intended to ensure that the module does not have to rely upon the shielding provided by the device into which it is installed in order for all modular transmitter emissions to comply with Part 15 limits. It is also intended to prevent coupling between the RF circuitry of the module and any wires or circuits in the device into which the module is installed. Such coupling may result in non-compliant operation.

2. The modular transmitter must have buffered modulation/data inputs (if such inputs are provided) to ensure that the module will comply with Part 15 requirements under conditions of excessive data rates or over-modulation.

3. The modular transmitter must have its own power supply regulation. This is intended to ensure that the module will comply with Part 15 requirements regardless of the design of the power supplying circuitry in the device into which the module is installed.

4. The modular transmitter must comply with the antenna requirements of Section 15.203 and 15.204(c). The antenna must either be permanently attached or employ a "unique" antenna coupler (at all connections between the module and the antenna, including the cable). Any antenna used with the module must be approved with the module, either at the time of initial authorization or through a Class II permissive change. The "professional installation" provision of Section 15.203 may not be applied to modules.

5. The modular transmitter must be tested for electromagnetic compatibility in a stand-alone configuration, *i.e.*, the module must not be inside another device during testing. This is intended to demonstrate that the module is capable of complying with Part 15 emission limits regardless of the device into which it is eventually installed. Unless the transmitter module will be battery powered, it must comply with the AC line conducted requirements found in Section 15.207. AC or DC power lines and data input/output lines connected to the module must not contain ferrites, unless they will be marketed with the module (see Section 15.27(a)). The length of these lines used during testing shall be a length typical of actual use or, if that length is unknown, at least 10

centimeters to insure that there is no coupling between the case of the module and supporting test equipment. Any accessories, peripherals, or support equipment connected to the module during testing shall be unmodified or commercially available (see Section 15.31(i)).

6. The modular transmitter must be labeled with its own FCC ID number, and, if the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: "Contains Transmitter Module FCC ID: XYZMODEL1" or "Contains FCC ID: XYZMODEL1." Any similar wording that expresses the same meaning may be used. The Grantee may either provide such a label, an example of which must be included in the application for equipment authorization, or, must provide adequate instructions to parties that may include the module in their product that such a label must be placed on the outside of the device. In the latter case, a copy of these instructions must be included in the application for equipment authorization.

7. The modular transmitter must comply with any specific rule or operating requirements applicable to the transmitter and the manufacturer must provide adequate instructions along with the module to explain any such requirements. A copy of these instructions must be included in the application for equipment authorization. For example, there are very strict operational and timing requirements that must be met before a transmitter is authorized for operation under Section 15.231. For instance, data transmission is prohibited, except for operation under Section 15.231(e), in which case there are separate field strength level and timing requirements. Compliance with these requirements must be assured.

8. The modular transmitter must comply with any applicable RF exposure requirements. For example, FCC Rules in Sections 2.1091, 2.1093 and specific Sections of Part 15, including 15.319(i), 15.407(f), 15.253(f) and 15.255(g), require that applicants for equipment authorization of Unlicensed PCS, U-NII and millimeter wave devices perform routine environmental evaluation for RF Exposure to demonstrate compliance. In addition, spread spectrum transmitters operating under Section 15.247 are required to address RF Exposure compliance in accordance with Section 15.247(b)(4). Modular transmitters approved under other Sections of Part 15, when necessary, may also need to address certain RF Exposure concerns, typically by providing specific installation and operating instructions for users, installers and other interested parties to ensure compliance.

32. We re-iterate that the requirements above are particular to modular transmitters in which all components are housed within a single enclosure. We propose to modify requirements 1, 2, and 5 in order to accommodate the special case of new partitioned modules in which the antenna, radio front end, and firmware are independent of one another.

33. *Requirement #1*. We propose to clarify that only the radio front end of a partitioned modular unit must be shielded. All components that require shielding would be required to be inside this unit. The other sections of the modular unit, the firmware that will be either part of another device or sit "stand-alone" on a platform and an antenna to complete the system, would not required to be shielded. We would also provide that the physical crystal and tuning capacitors can be located external of the shielded radio front end.

34. In addition, we are proposing that the interface between the sections of the modular

system must be digital with a minimum signaling amplitude of 150 mV peak-to-peak. Using this signaling level definition, interfering signals can be injected into this interface and the output can be tested for compliance with the regulations. We seek comment regarding alternative methods of demonstrating compliance with the FCC rules, including: a) impulse interference testing similar to that used in EN61000-4-4;[30] b) using a two-tone interference test and coupling the interferers into the cabling; and c) looking at interference levels required to degrade the bit error rate of the interference to an unacceptable level, (*i.e,.* typical interface bit error rates of 10^{-11}, degraded to 10^{-6}).

35. *Requirement #2.* This requirement deals with buffered modulation input to prevent over modulation. In self-contained modules, only data that is to be transmitted is presented as input. However for partitioned modules, control information (frequency, power, and radio operation) needs to be shared between the radio front end and firmware. Accordingly, we propose to update this requirement to allow control information and other data to cross the interface between the firmware and the radio front end.

36. *Requirement #5.* For the purpose of testing partitioned modules, we propose to define a "reference platform" that the radio manufacturer would build and submit for testing. At the minimum, a reference platform would consist of the radio front end, antenna, and an "environment" such as a PDA or laptop on which the firmware will operate. Any future changes to the radio front end or firmware would require re-testing on the pre-approved reference platform. The signal injection testing would be done on the implementation with a maximum length of cabling connecting the modular components. We seek suggestions regarding both the design of a reference platform and the length and type of cable used to connect the components.

37. In addition to the changes proposed above, we also propose to add a ninth requirement specific to partitioned modular transmitters to ensure that only a radio front end and firmware that have been certified together as a pair may operate with one another. This requirement will make certain that consumers or third parties do not mix and match radio front ends and firmware in combinations that may result in unauthorized operation. We propose to require that manufacturers implement a unique digital key or "Type Number" which allows approved radio front ends and firmware to recognize each other. We tentatively propose that the Type number will consist of a digital word 4 bytes in length with the following bit definition: 16 Bits for the Company information, 16 Bits for the Device Number. We seek comment on the practicality of implementing such a requirement. We encourage commenting parties to suggest appropriate methods for implementing this form of encryption for modular transmitters.

38. Finally, in order to comply with The National Environmental Policy Act of 1969 (NEPA) the Commission is required to evaluate the effects of our actions on the quality of the human environment.[31] One of several environmental factors addressed by these requirements is human exposure to RF energy emitted by FCC-regulated transmitters and facilities.[32] We realize that RF exposure compliance procedures for modular transmitters are not described in the 2000 *Public Notice*, and we have received numerous inquiries regarding the requirements for determining compliance with our RF exposure guidelines for these devices. Although we are not proposing, in this Notice, recommendations for determining compliance with our RF exposure rules, we direct interested parties to the recently adopted *Notice of Proposed Rule Making* in ET Docket 03-137.[33] We encourage those parties who are interested in

[30] *See,* "IEC 61000-4-4, Electromagnetic Compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test," published by the International Electrotechnical Commission.

[31] National Environmental Policy Act of 1969, as amended, 42 U.S.C. §§ 4321-4335.

[32] *See* 47 CFR § 1.1307(b).

[33] *Proposed Changes in the Commission's Rules Regarding Human Exposure to Radiofrequency Electromagnetic Fields*, Notice of Proposed Rule Making in ET Docket No. 03-137, 18 FCC Rcd 13187 (2003).

filing comments with regard to RF exposure limits applicable to modular transmitters to file such comments in that proceeding.

7. Improving Sharing in the Unlicensed Bands

39. The current rules for unlicensed devices specify limitations on such parameters as power and out of band emissions while still providing flexibility to accommodate various technologies. We observe that industry has developed standards such as Bluetooth and the 802.11 family of standards, which fit within the framework of our rules and provide some measure of assurance that multiple devices can co-exist. The Commission continues to develop and implement regulations that it believes will both support the demand for wireless operation and provide an environment that promotes efficient spectrum sharing. For that purpose, the Commission recently proposed rules to open new spectrum in the 5.8 GHz band for unlicensed operation under the condition that certain performance characteristics are met.[34] Furthermore, the Commission has initiated an inquiry asking questions regarding the possibility of allowing unlicensed devices to operate in spectrum reserved for television broadcast applications and in the 3560 - 3700 MHz band.

40. We invite comment on whether the Commission should consider any other methods to ensure efficient spectrum usage by unlicensed devices. For example, we note that the industry developed and the Commission adopted a "spectrum etiquette", or sharing conditions, for the operation of Unlicensed PCS devices operating under Part 15 of its rules.[35] The etiquette establishes a set of steps a device must follow before it may access the spectrum.[36] The etiquette requires that devices monitor the spectrum in which they intend to operate. The device may begin transmission only if no signal above a specified threshold is detected.[37]

[Alvarion Comment]

We do not agree with the proposal for spectrum etiquette. There are too many devices on the market today that use no spectrum etiquette. If new devices were introduced to the market that required such etiquette and were to co-exist with legacy "no etiquette" products still in use, they would be at a disadvantage and will not gain fair access to the spectrum. Also, systems using scheduled air protocols instead of "listen before send", such as those being designed in accordance to the IEEE802.16 standard, would be categorically denied operation under the Part 15 rules. We propose the use of use of a dynamic channel selection mechanism to find an open channel for operation instead of "listen before send". This dynamic channel selection mechanism can also include an option for the equipment to adjust the occupied bandwidth, allowing operation in narrower unused portions of the spectrum.

41. We invite comment on whether a spectrum sharing etiquette should be considered for devices that operate on an unlicensed basis, in addition to Unlicensed PCS devices. If so, should the Commission or the industry develop the criteria establishing access conditions? What characteristics need to be considered (*e.g.* spectrum monitoring requirements, bandwidth limits, variable output power levels)? Could an etiquette be implemented in such a way as to ensure continued flexibility for technological development, which has been the cornerstone of unlicensed operation? If a spectrum sharing etiquette is feasible, we seek comment regarding the bands to which the etiquette should apply. Finally, given the number of unlicensed devices currently in operation without a sharing etiquette, how

[34] *See Notice of Proposed Rule Making* in ET Docket 03-122, 18 FCC Rcd. 11581 (2003).

[35] *See* 47 C.F.R. Part 15, Subpart D – Unlicensed Personal Communications Service Devices.

[36] *See* 47 C.F.R. §§ 15.319, 15.321 and 15.323.

[37] 47 C.F.R. § 15.321(c)(1) – (7).

effective will such an etiquette imposed on new entrants be in improving spectrum sharing?

8. Special Temporary Authority

42. We are proposing to delete the provisions in Section 15.7 of the rules for obtaining a Special Temporary Authority (STA).[38] The Office of Engineering and Technology has not granted any STAs under Part 15 nor had any formal requests for an STA under these rules in the last 10 years. We believe that this need is being met through the allowances for STAs under the provisions in Part 5 for experimental licenses. We invite comment as to whether there is any need to maintain the Part 15 provisions for STAs.

Closing

The Commission is has made great strides in evolving the Part 15 rules to further spur on the enormous growth of the Wireless Broadband Access market. As always, Alvarion is pleased to be a party to this comment process, and we look forward to participating in future comment processes.

Respectfully submitted,

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[38] 47 C.F.R. § 15.7.